# VISION THERAPY in a SCHOOL SETTING

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**Abstract**

*The purpose of the present study was to evaluate the effects of vision therapy in a school setting in which elementary school children, enrolled in a reading-mentoring program, Caring Adults Teaching Children How (CATCH), were trained as a group. The experimental goal was to improve visual-motor and visual perceptual skills, with the use of vision therapy in short sessions given weekly at school, to children with reading difficulties. Sixty students were selected after the use of the Developmental Eye Movement test's (DEM) exclusion criteria and were randomly assigned into one of two groups: vision therapy and non-therapy. Both groups received CATCH tutorial visits once a week for 50 minutes. In addition, the therapy group received a weekly 30 minute activity session in which three activities were completed from the following: oculomotor, accommodation, binocularity, visual motor and visual memory. The results revealed that vertical and horizontal eye movements and accommodative facility were significantly improved after 22 sessions of group vision therapy. These improvements were related to attentional mechanisms leading to improved reading abilities. We believe this preliminary study gives evidence of the advantages of a program whereby vision therapy is provided in the elementary school setting to advance deficient visual skills that are related to learning and cognitive enhancement.*

**Key Words**

*vision therapy and reading, developmental eye movement test, accommodative facility, eye tracking*

## INTRODUCTION

Vision therapy is a non-invasive method of correcting visual disorders stemming from neuromuscular, neurophysiological, or neurosensory dysfunction.[1] These therapeutic procedures are designed to improve visual functioning and in turn information processing. Visual therapy can remediate existing visual problems, assist in the proper development of visual functioning, or even prevent certain visual problems from developing.

Problems in the visual system during ontogenetic and later development can lead to impediments in learning, and, in particular, difficulties in reading.[2,3] Further, there is a strong correlation between functioning of the parallel visual pathways and reading abilities.[4,5] Specifically, reading disabled children have been found to have deficits in the magnocellular (transient) visual pathway.[6-12] Deficits in this transient system, that control selective attention pathways, have been related to eye movement difficulties that in turn, have been shown to result in impediments in reading abilities.[13-15] Saccadic eye movements stimulate this transient system to inhibit the image from the previous fixation from persisting. Thus, when this transient system is deficient the efficiency and integration necessary for reading is decreased.[9,13] Taken together, saccadic control, left to right sequencing, and motor planning are involved in reading capabilities.

Although reading disabilities have a number of etiologies and require multiple approaches, it seems likely that efficient oculomotor functioning is a necessary ingredient for the high level of visual functioning required for reading and writing. A number of studies have shown that modification and improvement in oculomotor ability can be obtained with vision therapy.[1,16-19] In particular, Heath[18] found that following therapy, young children had improvement in oculomotor efficiency and scored significantly higher on a reading test.

Another component necessary for efficient visual functioning and appropriate information processing is the accommodative system. Accommodative infacility and accommodative insufficiency are two of the accommodative dysfunctions that can be improved through the application of vision therapy procedures.[1] Specifically, Hoffman[20] studied the effect of accommodative deficiencies on the developmental level of perceptual skills of school-aged children. The results revealed that with the use of vision therapy, accommodative deficiencies were improved with a simultaneous improvement in visual information processing tasks.

Optometric vision therapy for oculomotor dysfunctions and accommodative disorders most often involves a regimen of treatments consisting of individualized planned activities in a professional setting with guided supervision. These treatments may involve procedures that utilize highly complex instrumentation or may be relatively simple. We have found that in private practice the treat-

ments are most often given once or twice a week for an average of four to six months. The purpose of the present study was to evaluate such vision therapy in a school setting in which elementary school children, enrolled in a reading-mentoring program, were trained as a group. The experimental goal was to improve visual-motor and visual perceptual skills, with the use of vision therapy in short sessions given weekly at school, to children with reading difficulties.

Children with reading difficulties have a higher prevalence of visual dysfunctions. When these dysfunctions are remediated, there is evidence better reading skills result.[4,5,21] Therefore, this preliminary study is aimed at providing evidence that children who have reading difficulties, and receive vision therapy as a group, in a school setting, improve their level of visual functioning.

## METHODS

### Subjects

All subjects were recruited from the Community Magnate School located in Los Angeles, California. They were enrolled in the program Caring Adults Teaching Children How (CATCH), essentially a reading mentoring program for elementary school students. The CATCH program is supported by a State of California grant supplied by the Governor's Program on Child Development and Education/Academic Volunteer Mentoring Service.

Student selection criteria for the CATCH program consists of: 1) teacher recommendations at the end of the year, 2) results of the Stanford 9 test (below 50%) and, 3) the Community Magnate Achievement Test given by the school at the beginning of the school year. With the use of adult volunteers, the children are brought to a reading center and individualized tutorials for reading are given once a week.

### Subject selection process—-basic ocular and visual testing

For the vision therapy selection process, ninety students, enrolled in the CATCH program, representing first through fifth grade, were tested for visual functioning. The screening of these 90 CATCH students was accomplished by the use of 1) a visual acuity test, with the use of a Snellen Chart at 20 feet, 2) ophthalmoscopy to reveal eye health, 3) autorefraction with using a hand-held Nikon autorefractor, 4) binocularity – near point cover test, near point of convergence- (break and recovery), 5) stereopsis- using the Stereo Reindeer Test by Stereo Optical Co., 6) accommodation – accommodative facility (binocularly in cycles per minute), and 7) oculomotor – as evidenced by Developmental Eye Movement test (DEM). The DEM incorporates using two subtests of number naming, first in a vertical array and then in a horizontal array. Both subtests are timed and normalized using percentile scores with scores above 60% vertical and 50% horizontal representing above average saccadic functioning.[22]

Subjects were eliminated for the following reasons 1) 5 subjects for suspected pathology or any refractive error greater than +1.00 or – 0.50 and 2) 25 subjects for DEM scores either >60% vertical or >50% horizontal (above average functioning and not likely to benefit from the proposed therapy). Although we tested other areas of visual functioning, we used the DEM scores as our main selection criteria because they are suggested factors in accommodation, vergence, and sensory and perceptual functioning.[4,5]

The 60 students that remained following use of the above selection criteria were randomly assigned into one of two groups: vision therapy and non-therapy. Both groups received CATCH reading tutorial visits once a week for 50 minutes. We planned to give the non-therapy group a matching placebos session. However, virtually all parents of children in this proposed group refused to have their children participate when the reason for the placebos session was explained.

### Visual processing testing

Pre-therapy testing - Prior to the onset of therapy both groups were further tested for the following:

1. The Test of Visual Perceptual Skills (TVPS) was used to determine a subject's visual-perceptual strengths and weaknesses based on non-motor visual perceptual testing. The complete test has seven areas, however, the three tests that were most clinically significant for the present hypothesis were chosen.[23]
   a. Visual Discrimination (VD) - ability to match or determine exact characteristics of two forms when one of the forms is among similar forms.
   b. Visual Memory (VM) - ability to remember for immediate recall all of the characteristics of a given form and being able to find this form from an array of similar forms.
   c. Visual Closure (VC) - ability to determine, from among 4 incomplete forms, the one that would be the same as the completed form.
1. Beery-Buktenica Developmental Test of Visual Motor Integration (VMI) - a developmental sequence of geometric forms to be copied with paper and pencil.[24]

Midterm testing - At midterm, which is four months after therapy was initiated, each student was tested for DEM-both horizontally and vertically.

Final Testing – At the end of the school year, both groups of students were tested for DEM, both horizontal and vertical, TVPS (three sections: VD, VM, VC), accommodative facility, and the VMI test.

### Vision Therapy Procedures

Twenty-two weekly vision therapy visits were completed. Each visit was 30 minutes and students were taken from their classrooms to a specified room on site. No home therapy was administered.

The experimental group consisted of five sub groups (first through fifth grade) each receiving 30 minutes of therapy weekly with four to six subjects in each group. There were approximately two therapists for every three students. A computer was available for each session for orthoptics vergence training.

### Vision Therapy Activities

During each 30-minute visit, three different activities were completed. The activities utilized were selected for ease of use in a school setting from the following:
*Oculomotor:* head rotation, target saccades, rotator with Russell Ring, Ann Arbor number and letter tracking books.
*Accommodation:* near to far Hart Chart, plus and minus lens flippers.
*Binocularity:* Brock String, physiological diploplia, eccentric circle cards, Computer Orthoptics- vergence and jump ductions, vectograms- nearpoint.
*Visual Motor:* Rhythmic writing and continuous motion both performed on chalkboard and at the desk.

*Visual Memory:* tachistiscopic imaging with targets such as X's and O's, and two arrows.

## RESULTS

### Developmental Eye Movement

Vertical - There was a statistically significant improvement in vertical eye tracking in the therapy group compared to those not treated when tested at the midterm point, $F(1,45) = 3.81$, $p < .05$. As seen in Figure 1A, the therapy group at each grade level had a greater percentile vertical tracking score than the non-therapy group. End of year vertical tracking scores compared to midterm scores showed another significant treatment effect, that is, while each group improved their scores, the therapy group scores remained higher, $F(1, 43) = 5.00$, $p < .03$ (Figure 1B). When comparing all 3 vertical eye tracking scores, there was a significant improvement across the year for the group receiving therapy, $F(1,43) = 4.92$, $p < .03$, demonstrating a continued improvement in the therapy group. There was no significant difference between grades or treatment interaction with grade.

Horizontal - Testing for horizontal eye tracking at mid year showed a statistically significant increase in performance for those receiving therapy, $F(1, 46) = 5.54$, $p < .02$ (Figure 2A). Midterm horizontal tracking scores compared to the final scores produced a statistically significant interaction between treatment group and time, $F(1, 41) = 5.21$, $p < .03$ (Figure 2B). This implies that, whereas the therapy group demonstrated most of their improvement in DEM-horizontal in the first half of the year, the non-therapy subjects had an equal amount of improvement occurring in the second half of the year.

### Accommodative Facility

Comparing pre-therapy accommodative facility with post-therapy scores showed a highly significant improvement across all grades, $F(1, 48) = 6.687$, $p < .01$. As seen in Figure 3, subjects who had received therapy showed a greater number of cycles per minute in this eye-focusing task compared to the non-therapy subjects.

Interestingly, the majority of subjects demonstrated some improvement in accommodative facility from their initial score. However, of those receiving therapy, all groups of subjects improved significantly (Table 1).

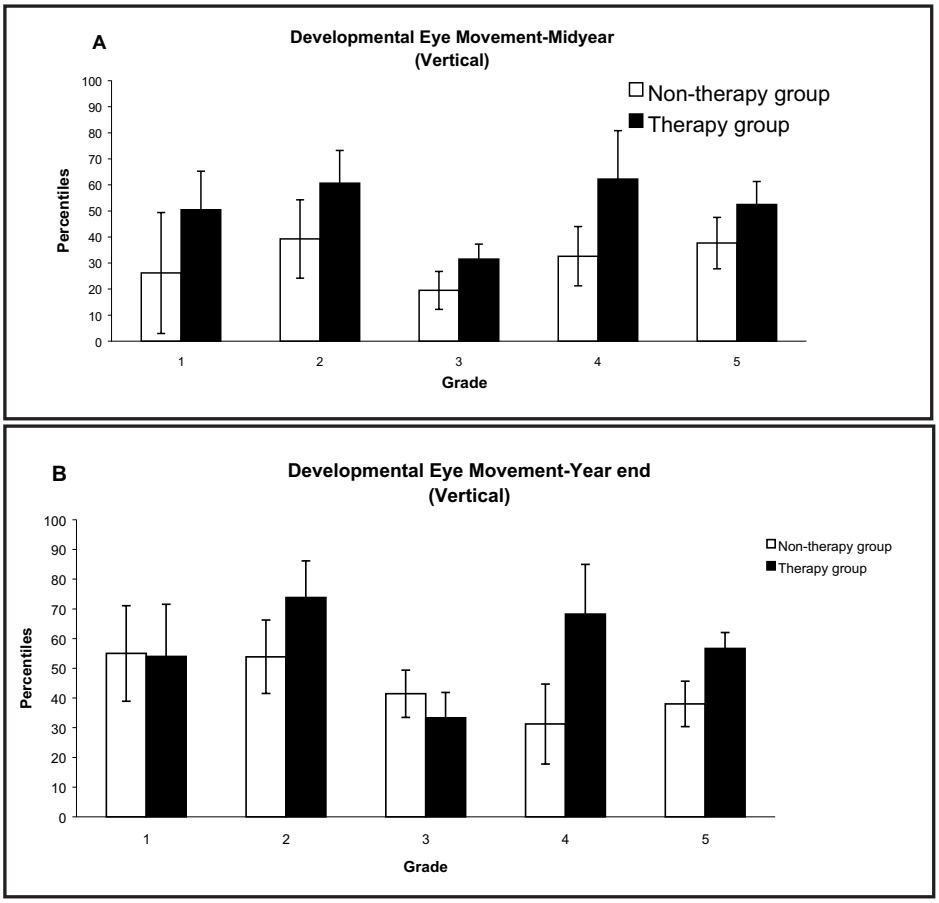


*Figure 1: The mean (" SEM) percentile score for developmental eye movement, vertical tracking, for the therapy group in each grade was significantly greater than the non-therapy group at the A. midyear test and B. year end test.*

**Table 1**

| Grade | Group | Initial score | Initial score | Difference score |
|---|---|---|---|---|
| 1 | Therapy | 4.50 | 9.50 | + 5.00 |
| | Non-therapy | 5.33 | 6.67 | + 1.34 |
| 2 | Therapy | 6.14 | 11.00 | + 4.86 |
| | Non-therapy | 6.50 | 5.19 | - 1.30 |
| 3 | Therapy | 6.57 | 11.86 | + 5.29 |
| | Non-therapy | 4.14 | 3.71 | - 0.43 |
| 4 | Therapy | 4.60 | 6.40 | + 1.80 |
| | Non-therapy | 1.33 | 5.08 | + 3.75 |
| 5 | Therapy | 2.00 | 9.80 | + 7.80 |
| | Non-therapy | 6.50 | 3.50 | - 3.00 |

*Table 1 presents the initial cycles/minute accommodative facility score for each group (therapy and non-therapy) for each grade, their final score at the year end test, and difference between the two scores. In general, the groups receiving therapy showed a greater difference score compared to the non-therapy group.*

### Test of Visual Perceptual Skills

Visual Closure and Visual Discrimination did not show a significant change over time or following therapy. Scores for visual memory did improve over time for both the therapy and non therapy groups, $F(1, 46) = 18.50$, $p < .0001$.

### Visual Motor Integration

There was no significant effect of therapy on this test.

## DISCUSSION

The present study revealed that the level of visual functioning, as evidenced by the DEM and accommodative facility, can be improved by 22 sessions of vision

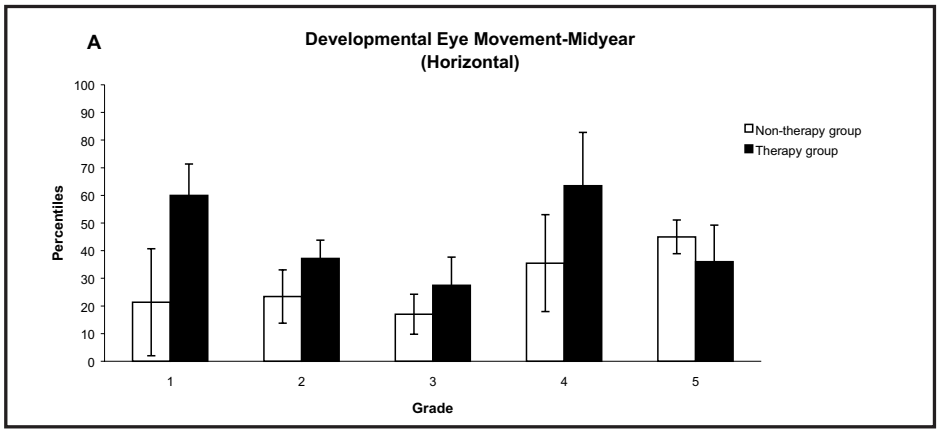


*Figure 2: The mean (" SEM) percentile score for developmental eye movement, horizontal tracking, for the therapy group in each grade was significantly greater than the non-therapy group at the A.*

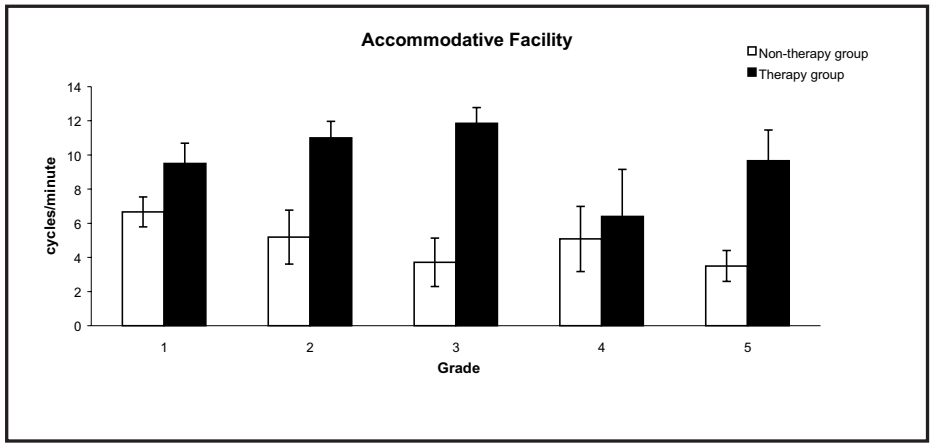


*Figure 3: The mean (" SEM) cycles/minute for accommodative facility was significantly greater in the therapy group compared to the non-therapy group at the year end test.*

therapy given to children in an elementary school setting.

In general, a greater amount of oculomotor improvement was seen at the midterm in part because the first half of the vision therapy program emphasized eye movement tasks, while the second half put greater emphasis on visual motor and perceptual activities. Even though the vertical and horizontal eye movement therapeutic activities were somewhat reduced in the second half of the year, the students in the vision therapy group still continued to improve, but at a slower rate. The vision therapy group had a vast improvement in vertical eye movements at the mid-year test. Furthermore, both groups improved in the second half, but the therapy group maintained their relative lead. In contrast, in the horizontal eye movement test, the control group improved to a greater extent in the second half of the year compared to the therapy group, with no significant difference overall.

It has been suggested that the vertical subtest is related to visual-verbal automaticity, the horizontal subtest correlates with vigilance, and decreases in accuracy may be due to attentional shifts.[25] As Coulter[25] points out, the DEM test alone does not allow for the differentiation of these two functions. However, using the DEM horizontal test separated into two parts, the subjects demonstrated a decline in accuracy during the second section, suggesting a shift in attention. In the present study, both the horizontal and vertical DEM scores improved significantly at mid-year following vision therapy, and continued to improve at the end year test at which point the non-therapy group caught up in the horizontal scores alone. Whether the improvements in these tests represent specific gains in automaticity and attentional mechanisms remains to be determined.

Another measure of visual attention is accommodative facility, that greatly improved in our vision therapy group. While the majority of all subjects showed an improvement in their accommodative facility, the therapy group had a mean score higher than the non-therapy group at each grade level. These improvements may mean that the student can better focus and concentrate without being distracted for a longer period of time with less fatigue and stress occurring. In fact, accommodative facility along with certain visual perceptual skills are predictive of reading aptitude in children.[4,5]

There were no significant differences found in either the test of visual perceptual skills or visual motor integration. We hypothesize that this is because these skills require more therapy time to develop and may require a more individualized program. Our vision therapy program was too diversified and future studies should limit the categories to include training for oculomotor, accommodation, and binocular functions. A school setting presents the therapist with a complex social environment and various distractions that are not often found in the office setting. Therefore, the school vision therapy program should be more basic and less complicated to accommodate a group of elementary children. However, we were successful in improving the visual functioning of reading deficient children in a busy school environment, using relatively few resources. We believe that it would be

advantageous to develop a program whereby vision therapy could be provided in the school setting to advance visual skills in order to improve cognitive functioning.

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